Inside NIDCD Newsletter

National Institute on Deafness and Other Communication Disorders
National Institutes of Health
www.nidcd.nih.gov

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IN THIS ISSUE

Feature Story

Giving Voice to Thoughts: NIDCD-Funded Research Helps the Locked-In Communicate Again by Turning Thoughts into Words

By Robin Latham

A middle-aged woman, paralyzed except for the ability to tilt her head and move her eyes, sits in a wheelchair. Extending from the top of her head is a plug, with a cord running from it to a computer linked to a monitor. On the monitor screen is a display of a standard QWERTY keyboard. Silently a cursor moves across the keyboard. Asked how she likes using this system, she deliberately picks out the letters E-X-C-I-T-I-N-G. Amazingly, she does this just by thinking of her hand controlling and clicking an imaginary mouse.

The device that links the brain of this stroke survivor to a computer and restores her ability to communicate with the world is called BrainGate2, and its development is the pioneering work of a team of researchers funded by the National Institute on Deafness and Other Communication Disorders (NIDCD), the National Institutes of Health (NIH), and the U.S. Department of Veterans Affairs (VA). They are using what's known as brain-computer interface technology to turn thoughts into words by recording signals in the brain that normally direct movement and then using computer programs to turn those signals into actions.

Locked-in syndrome is a state of near-total paralysis that happens as a result of injury or brain degeneration when the link has been broken between the movement centers of the brain, including the motor cortex, and the rest of the body. It can happen after brain-stem stroke or traumatic brain injury and can also be a long-term consequence of neuromuscular disease, such as amyotrophic lateral sclerosis (ALS, or Lou Gehrig's disease). People with locked-in syndrome are still vibrantly alive in their minds, with the ability to think and feel. But without movement or speech, there is currently very little they can do to communicate with the world.

BrainGate2 is the brainchild of a group of neuroscientists and neuroengineers based at Brown University in Providence, R. I. NIDCD grantee Leigh Hochberg, M.D., Ph.D., affiliated with Brown and the VA Medical Center in Providence, and Massachusetts General Hospital and Harvard Medical School in Boston, leads the effort to make this investigational technology a communication tool for the locked-in. Without even moving an eyelid, someone with locked-in syndrome only has to imagine moving his or her hand on a computer mouse to make the cursor move on the computer screen.

(continued on page 2)

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"The signals are the same signals that would have ordinarily controlled movement of the arm or the hand," says Dr. Hochberg, "and now they've been harnessed to control an imagined computer mouse."

According to Dr. Hochberg, this clinical trial of BrainGate2 wouldn't be possible without NIH's neural prostheses programs, which have been encouraging for decades the development of technology that allows the brain to interact directly with a computer. The initial preclinical studies and the development of the implanted device that are key to BrainGate2 were developed under one of these programs by John Donoghue, Ph.D., also at Brown. But Dr. Hochberg adds that BrainGate2 is ultimately the result of the accumulation of knowledge from 40 years of NIH- and VA-sponsored research into the activities of the motor cortex, an area at the top of the brain, which is important in controlling body movement. "We understand a lot about this part of the brain," says Dr. Hochberg, "and how individual neurons in the motor cortex contribute to the generation of voluntary movement."

But as much as they knew about how the motor cortex worked, Dr. Hochberg's team still had to overcome several hurdles to bring their device to life. The first was in developing a method to "decode" action potentials, brief pulses or firings of electrical energy, which the brain uses to transmit information between and among neurons. Previous work by Dr. Hochberg and others had looked at patterns of activity in populations of neurons in the motor cortex and observed an association between changes in action potential firing rates and the speed and motion of actual hand movement. Using a mathematical algorithm and computer software, it became possible to translate the neuronal activity of the motor cortex into clear directional signals.

The other challenge was to show that the signals in the motor cortex that generate movement remain intact, even after the connection between the brain and the muscles is lost. It has been common wisdom in neurophysiology circles that the brain operates on a kind of "use it or lose it" basis, so that neural circuits that aren't used regularly often reorganize or take on a different purpose. But Dr. Hochberg and his team have found familiar patterns and strengths of motor cortex signals in people who have participated in their study, regardless of how long ago they had been injured.

So, if the signals were still strong and programs could be written to decode them, hooking up the brain to the computer could unlock the locked-in and allow them to communicate again.

The hardware of BrainGate2 is relatively simple. A tiny implanted microarray sensor records the activity of dozens to a hundred or more neurons in real time and transmits them to a plug attached to the scalp. These signals travel to a computer, which is programmed to translate them into the movement of a cursor on the monitor screen. "The signals are the same signals that would have ordinarily controlled movement of the arm or the hand," says Dr. Hochberg, "and now they've been harnessed to control an imagined computer mouse."

Right now the equipment is cumbersome and the only people who can use it are the pioneering participants who have been enrolled in the study and, even then, only when someone is there to turn the system on. "It's about at the same stage as the first heart pacemaker, when you pushed it along in front of you on a cart," says Dr. Hochberg. But he believes that will change as the device is refined, miniaturized, and fully implanted in the motor cortex where it can beam information to the computer using wireless technology.

In the meantime, Dr. Hochberg is grateful for the continued participation of the small group of individuals who have donated their time and effort to help him and his fellow researchers test and refine the device.

"The pioneering spirit and generosity of our participants, and their valuable feedback, are showing us what this technology needs to become," Dr. Hochberg says. "They've enrolled in this clinical trial not because they're going to directly benefit. They've enrolled so they can help develop a device that will someday help other people with communication disorders and paralysis."

To learn more about Dr. Hochberg and his colleagues' work, visit the BrainGate2 website at **http://www.braingate2.org/**.

Inside NIDCD Newsletter

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www.nidcd.nih.gov

Fall 2010

Recent Research and News

New NIDCD Research Offers Intriguing Clues About the Role of Smell in Food Preference

Two mice exploring their lunch option.

Scientists have noticed for decades that rodents take their dining clues from their peers, basing their preferences for different foods on the last thing one of their buddies ate. It's a behavioral strategy that could be seen as a way to stack the deck against eating harmful or poisonous foods. Earlier studies had shown that it was the odor of carbon disulfide (a byproduct of food metabolism) on the breath of the other mouse or rat, combined with the scent of bits of food clinging to their fur and whiskers, which acted as a social cue. But no one had been able to explain how the brain put the two odors together to signal "okay to eat." NIDCD-funded researcher Steven Munger, Ph.D., at the University of Maryland School of Medicine, along with an international team of researchers, used knock-out mice to show that the behavior is the result of a dedicated subsystem of specialized olfactory receptors in the nose and neural circuits in the brain. This subsystem involves a small family of olfactory receptors called the GC-D+ neurons that send signals to the necklace glomeruli, specialized clusters of neurons in the olfactory bulb that act as a way station for signals as they move from the nose to the brain. Unlike most glomeruli, the necklace glomeruli integrate multiple sensory inputs, which allow them to pair the two odors and alert the olfactory brain. The finding offers clues for humans about how we learn to associate behavior with odor. Read more on the NIDCD website at **http://www.nidcd.nih.gov/news/releases/10/081610.htm**. The study is published in Current Biology. Read an abstract of the study in Pub Med at **http://www.pubmed.gov** and search for PMID 20637621.

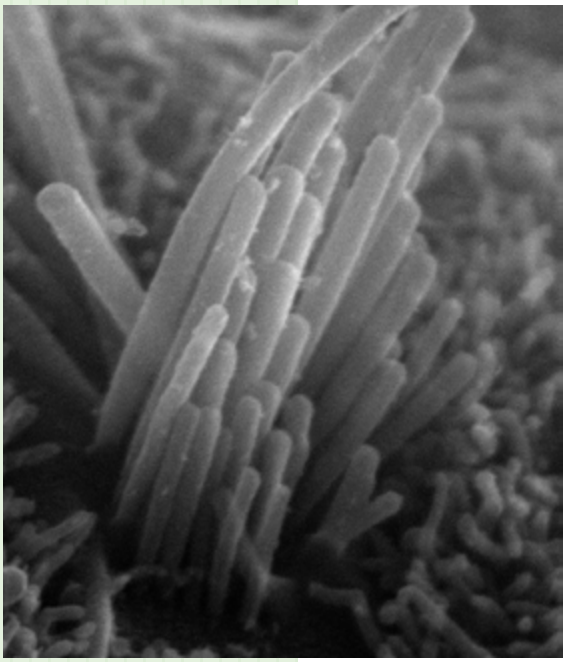
What You Can't Hear Won't Hurt You? Maybe Not

Wind turbines, giant propellered contraptions that turn wind power into electricity, are rapidly becoming popular as green energy sources in Europe and the United States. This is good for the environment, but the rotors and blades of wind turbines generate noise in the infrasound range that some people claim makes them feel dizzy or unable to sleep, among other symptoms. Infrasound is defined broadly as any sound lower than 20 Hertz (Hz), which is the lowest pitch that most people can hear. Many scientists assume that frequencies too low to be heard can't have any effect on the function of the ear. But NIDCD-funded researcher Alec Salt, Ph.D., at Washington University in St. Louis, has observed otherwise. For years, he and his colleagues have used infrasound as a way to slowly displace the structures of the inner ear for study in the lab, and they noticed inner ear function being disturbed by frequencies as low as 5 Hz. Salt believes that outer hair cells, which normally help amplify sound vibrations in the inner ear, actively work to keep the inner hair cells, which turn sound waves into electrical signals destined for the brain, from being stimulated by lower frequencies. While the brain may not hear the sound, the responses of the outer hair cells could cause unfamiliar sensations in some people. Read more on the NIDCD website at **http://www.nidcd.nih.gov/news/releases/10/07_28_10.htm**. The study is published in Hearing Research. Read an abstract of the study in Pub Med at **http://www.pubmed.gov** and search for PMID 20561575.

Inside NIDCD Newsletter

National Institute on Deafness and Other Communication Disorders
National Institutes of Health
www.nidcd.nih.gov

Fall 2010



Hair cells grown from mouse embryonic stem cells display their characteristic stereocilia.
Credit: S. Heller and K. Oshima

The First Recipe for Cooking Up Functional Hair Cells from Stem Cells

Each of our ears harbors only 15,000 hair cells, the tiny sensory cells in the cochlea that turn sound vibrations into electrical signals. Once they are damaged or die, we are unable to make new ones. Losing them, even only a thousand or so, means losing hearing ability. Scientists have always been frustrated by their scarcity and how difficult it is to extract them from the ear, and these issues have hindered experimentation. Now, thanks to research funded by the NIDCD and conducted by Stefan Heller, Ph.D., and a group of colleagues at Stanford University School of Medicine, scientists have a way to grow abundant numbers of functional inner ear hair cells using embryonic mouse stem cells and a combination of growth-inducing substances. The findings bring the scientists closer to achieving two main goals. Short range, their goal is to grow large numbers of working hair cells for further research. Long range, they hope to use what they discover to restore the ear's ability to regenerate hair cells. According to lead researcher Heller, "It's like having an ear in a test-tube." Read more on the NIDCD website at **http://www.nidcd.nih.gov/news/releases/10/07_02_10.htm**. The study is published in Cell. Read an abstract of the study in Pub Med at **http://www.pubmed.gov** and search for PMID 20478259.

NIDCD Highlights

Noisy Planet Highlighted in Acoustics Today

Acoustics Today, a quarterly publication of the Acoustical Society of America (ASA), is featuring an article about the NIDCD's Noisy Planet campaign in its October 2010 issue. It's a Noisy Planet. Protect Their Hearing is a national educational campaign to increase awareness about noise-induced hearing loss (NIHL), which is caused by overexposure to loud noise. The campaign's primary target audience is the parents of tweens—kids ages 8 to 12. The message of Noisy Planet fits in well with the ASA's longterm involvement in studies of noise, its measurement, its effects, and ways of reducing noise to improve the human environment. To learn more about the Noisy Planet campaign and its partner activities, go the Noisy Planet website at **http://www.noisyplanet.nidcd.nih.gov/partner/**. Sign up for the Noisy Planet e-bulletin at **http://www.nidcd.nih.gov/news/subscribe.htm** to keep informed about the availability of new materials and activities.

Noisy Planet on the Road

Want your children to know more about how to protect their hearing? Schools, parent-teacher organizations, and faith-based groups in the Washington, D.C., metropolitan region can have Noisy Planet come to them! The 45-minute presentation, led by NIDCD communication staffers, uses fun, science-based, hands-on activities to show how loud noise affects hearing and what can be done to prevent noise-induced hearing loss. Contact Robert Miranda-Acevedo at (301) 496-7243 or **miranda1@mail.nih.gov**.

NDCD Advisory Council Adds Five New Members

The National Deafness and Other Communication Disorders (NDCD) Advisory Council welcomed five new members at its most recent meeting, held in September. The meeting included a presentation

NIDCD Director Dr. James F. Battey (center) with new council members (l-r) Drs. Gerald Berke, Lauren Bakaletz, Saumil Merchant, and Bevan Yueh. Dr. Carolyn Stern is not pictured.

by NIH Director Francis Collins, M.D., Ph.D., who highlighted notable NIDCD research advances and participated in an informal Q&A session. The council advises the director of the NIDCD on matters relating to the Institute's core mission areas of hearing, balance, smell, taste, voice, speech, and language. The term for council members is four years.

Lauren Bakaletz, Ph.D., is a professor in the department of otolaryngology, Ohio State University, and vice-president for basic science research at the Research Institute at Nationwide Children's Hospital, Columbus, Ohio. Dr. Bakaletz's work involves understanding the pathogenic mechanisms operating in otitis media, particularly the roles of bacterial adhesives and biofilm formation.

Gerald Berke, M.D., is chief of head and neck surgery in the school of medicine at the University of California, Los Angeles. Dr. Berke's scientific work includes voice disorders, swallowing problems, snoring, deviated or perforated septa, and parathyroid and thyroid disease and trauma.

Saumil Merchant, M.D., is the Gudrun Larsen Eliasen and Nels Kristian Eliasen chair in otology and laryngology at Harvard Medical School. Dr. Merchant's research interests explore pathology of the middle ear to better understand sound transmission in normal, diseased, and reconstructed tissue.

Carolyn Stern, M.D., is a family physician and partner of DeafDoc.org, a website that explains health care issues using American Sign Language and captions. She also works as an urgent care physician in the Unity Health System and is medical director at the Rochester School for the Deaf.

Bevan Yueh, M.D., M.P.H., is a professor and chair of the department of otolaryngology/head and neck surgery at the University of Minnesota. Dr. Yueh's scientific interests include head and neck surgery, clinical epidemiology, and tumors of the head, neck, salivary gland, and thyroid.

Grants News

NIDCD Grantee Receives 'Genius Award'

Dr. Carol Padden, recipient of a MacArthur Foundation "genius" award.

NIDCD grantee Carol Padden, Ph.D., is the recent recipient of what is popularly known as a "genius" award from the MacArthur Foundation—a fellowship that comes with a stipend of $500,000.

Dr. Padden is a professor of communication at the University of California, San Diego, where she also received her Ph.D. in linguistics. Her research focuses on the unique structure and evolution of sign language. She has most recently focused on Al-Sayyid Bedouin Sign Language, from the south of Israel, which was created within a closed community approximately 75 years ago. By investigating the structure of this emerging sign language, Dr. Padden and her team will be able to trace the roots of language evolution as it develops naturally within a community.

The MacArthur Fellowship Program was established in 1981 to enable recipients to exercise their own creative instincts for the benefit of human society. "The freedom to pursue novel ideas is something I've always wanted to do," says Dr. Padden, "and I'm grateful for the opportunity."

Dr. Padden is the first deaf individual to receive the prestigious award, which has been given to 823 individuals since its inception. The award allows recipients to work on any project that interests them, with no requirements for specific products or reports.

You can learn more about Dr. Padden on her website at **http://communication.ucsd.edu/cpadden/**.

Meetings of Interest

American Public Health Association (APHA)
November 6-10, Denver, Colo.
Web info: www.apha.org/meetings

Learn from experts in the field, hear about cutting-edge research and exceptional best practices, discover the latest public health products and services, and share your public health experience with your peers. APHA's meeting program addresses current and emerging health science, policy, and practice issues in an effort to prevent disease and promote health.

Society for Neuroscience (SfN)
November 13-17, San Diego, Calif.
Web info: www.sfn.org/AM2010

Through lectures, symposia, workshops, and events, the SfN annual meeting is the premier venue for neuroscientists from around the world to debut cutting-edge research. Since 1971, the meeting has offered attendees the opportunity to learn about the latest breakthroughs and network with colleagues throughout North America. Visit the NIDCD booth (4112) in the Exhibit Hall.

American Speech-Language-Hearing Association (ASHA)
November 18-20, Philadelphia, Pa.
Web info: www.asha.org/events/convention

Leadership into New Frontiers focuses on what speech-language-hearing professionals need to make a difference in the lives of the people they serve. In addition to program sessions, a career fair, poster sessions, and other activities, the keynote speaker is Nancy Goodman Brinker, founder of the Susan G. Komen Breast Cancer Foundation. Visit the NIDCD booth (1132) in the Exhibit Hall.

Association for Research in Otolaryngology
February 19-23, Baltimore, Md.
Web info: http://www.aro.org/mwm/mwm.html

The ARO annual midwinter meeting gives researchers and otolaryngology professionals an opportunity to meet and discuss the latest advances in otolaryngology research. This year will feature symposia, workshops, presentations, special interest group socials, special events, and exhibits. The Presidential Symposium will focus on genomics and its impact in otolaryngology.

Beyond NIDCD: News from Other Organizations

The Deafness Research Foundation (DRF) recently announced that it has awarded $550,000 to 22 outstanding research scientists in the field of hearing and balance science, which represents a 16 percent increase in the organization's grant making. DRF awards research grants of up to $25,000 to young investigators to conduct novel investigations of auditory and vestibular function and dysfunction. Research proposals for basic, translational, and applied clinical research in hearing and balance are considered for funding. Applications for the 2011 DRF grant cycle are due on December 8. To be notified of upcoming grants, send an email to **grants@drf.org**.

The Center for Disease Control and Prevention's (CDC's) Advisory Committee on Immunization Practices (ACIP) has updated its recommendations for vaccination to prevent pneumonoccal disease and ear infections. ACIP recommends that children ages 6 weeks to 5 years receive the recently approved 13-valent pneumococcal conjugate vaccine, PCV13, in place of the currently used 7-valent PCV7. The new vaccine is administered in a four-dose series at ages 2, 4, 6, and 12-15 months.

Children who started their vaccination series with PCV7 should complete the series with PCV13. In addition, a booster dose of PCV 13 is recommended for children as old as 59 months who have completed the four-dose PCV7 series.

To read more, go to the CDC's vaccine information statement at **http://www.cdc.gov/vaccines/pubs/vis/downloads/vis-pcv.pdf**.

The Childhood Apraxia of Speech Association presents "Childhood Apraxia of Speech: New Perspectives for Assessment and Treatment" on January 21, 2011, at the Thompson Conference Center at the University of Texas, Austin. The speaker, David W. Hammer, M.A., CCC-SLP, will offer a hands-on, practical presentation that focuses on strategies for therapists who treat children with apraxia of speech. For more information, contact Kathy Bauer, education director for the Childhood Apraxia of Speech Association at **kathyb@apraxia-kids.org** or visit the website at **http://www.apraxia-kids.org/**.

Hands and Voices is devoted to improving support for families with children who are deaf or hard-of-hearing and the professionals who serve them. Resources for parents include:

A is for Access (DVD) is a guide for families and educators about how to create and implement full and effective communication access for students who are deaf or hard-of-hearing. Order online at **http://www.handsandvoices.org/pdf/AAccOrdFrm.pdf**.

The Book of Choice, 3rd Edition, in English and Spanish, is an information resource based on the most frequently asked questions by parents of deaf and hard-of-hearing children. Order online at **http://www.handsandvoices.org/resources/pubs/OrderForm8-21-09.pdf**.

(continued on page 8)

Inside NIDCD Newsletter

National Institute on Deafness and Other Communication Disorders
National Institutes of Health
www.nidcd.nih.gov

Fall 2010

Changing Brains: Effects of Experience on Human Brain Development (DVD) uses information and practical recommendations based on scientific evidence to explain what you can do to help children develop to their full potential. Nine segments describe the brain systems important in vision, hearing, motor skills, attention, language, reading, math, music, and emotions and learning. The DVD was developed with NIDCD funding by Helen J. Neville, Ph.D., at the University of Oregon. Watch or order online at their website at **http://changingbrains.org/**.

NOHR FOUNDATION THE NATIONAL ORGANIZATION FOR HEARING RESEARCH FOUNDATION

The National Organization for Hearing Research Foundation (NOHR) has a newly designed website at **http://nohrfoundation.org/**. The organization funds biomedical research into the preventions, treatments, causes and cures of hearing loss and deafness.

New Resources

The Noisy Planet Website: It's Not Just in English Anymore! ¿Habla usted español?

It's a Noisy Planet. Protect Their Hearing is an educational campaign that helps parents of tweens learn about the dangers of overexposure to loud noise at a young age and how to protect their hearing for life. Now the website also offers online and printable information in Spanish here: **http://www.noisyplanet.nidcd.nih.gov/parents/.**

Updated Fact Sheets Online

The following NIDCD fact sheets have been updated to reflect new research, treatments, and diagnostic methods:

Ear Infections in Children at **http://www.nidcd.nih.gov/health/hearing/earinfections.htm**.

Ménière's Disease at **http://www.nidcd.nih.gov/health/balance/meniere.html**.

Tinnitus at **http://www.nidcd.nih.gov/health/hearing/tinnitus.htm.**

Time to Think About the New Year

And what better way to keep track of the days than with a Noisy Planet calendar? The 2011 calendar comes in an easy to use 8½ by 5½ inch size and can be applied, removed, and reapplied to smooth surfaces. Perfect for the fridge or your desk! Order toll-free at 800-241-1044 or 800-241-1055 (TTY). Order soon! The 2010 calendars went quickly.

NIDCD Seminar Series Announces 2010-2011 Schedule

The NIDCD Division of Intramural Research presents a seminar series focusing on the basic mechanics of auditory function and hearing disorders. The seminar series brings speakers from national and international universities to the NIH campus and offers an opportunity to strengthen scientific interactions within the NIDCD and extramural communities. The seminar series is held on the first Tuesday of each month through June 2011. For a full listing of seminars, visit the NIDCD website at **http://www.nidcd.nih.gov/news/SeminarSeries2010-2011.htm**.

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